

## The Arithmetic of Printing Images

Printer resolutions are usually specified by the number of dots per inch (dpi) that they print. (Generally ppi—pixels per inch—refer to the image and display screen and dpi—dots per inch—refer to the printer and printed image. In this course we sometimes use them interchangeably.)

### Excel Worksheet

The calculations described in this section are nothing more than subtraction, addition, multiplication, and division. However, to make it easier to explore the various relationships being discussed, you can download an Excel worksheet "Image Size Calculator" that will help you better follow the discussion and explore the concepts we discuss. The worksheet has been saved in Excel 5 format so that version and all later versions can read it. To download the unzipped version (20 Kilobytes), [click here](#).

For comparison purposes, monitors use an average of 72 ppi to display text and images, ink-jet printers range up to 1700 dpi or so, and commercial typesetting machines range between 1,000 and 2,400 dpi.

Since image sizes are described in pixels and photographic prints in inches, you have to convert from pixels to inches. To do so, you divide the image's dimension in pixels by the resolution of the device in pixels per inch (ppi). For example, to convert the dimensions for a 1500 x 1200 image being printed at 300 ppi you divide as follows:

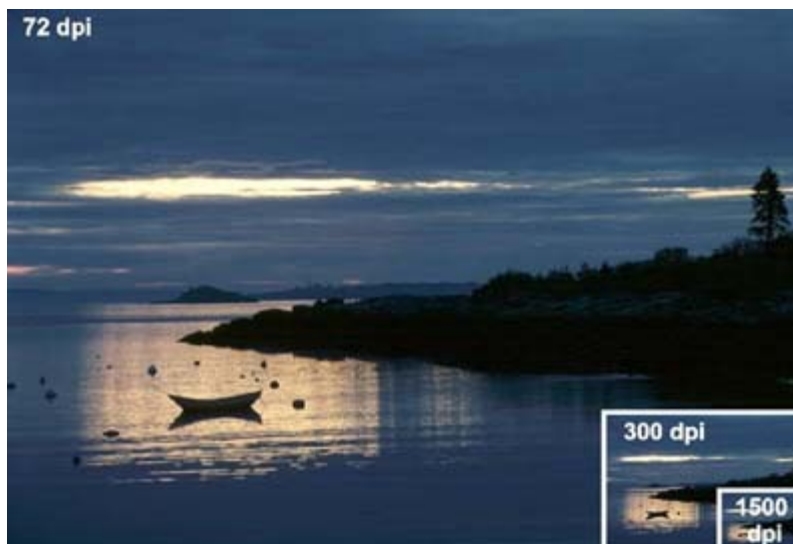
$$\text{Width: } 1500 \text{ pixels} \div 300 \text{ ppi} = 5"$$

$$\text{Height: } 1200 \text{ pixels} \div 300 \text{ ppi} = 4"$$

The result is a 5" x 4" print. However, if the output device prints 600 ppi, the result changes to a 2.5" x 2" print as follows:

$$\text{Width: } 1500 \text{ pixels} \div 600 \text{ ppi} = 2.5"$$

$$\text{Height: } 1200 \text{ pixels} \div 600 \text{ ppi} = 2"$$



*This graphic shows how a 640 x 480 image displays or prints on devices with different dots per inch. At 72 ppi it's 8.9" x 6.7", at 300 ppi it's 2.1" by 1.6", and at 1500 ppi, it's only 0.43" x 0.32"—smaller than a stamp.*

## ▲ Exploring Print Sizes

This figure and Part 3a on the Excel worksheet "Image Size Calculator" calculate the size of print you can expect from a given file size and printer resolution.

3a. Printing Images-Print Sizes		
1	Width of digital image	1,600 pixels
2	Height of digital image	1,200 pixels
3	Printer's resolution	300 dpi
4	Width of print	5.33 inches
5	Height of print	4.00 inches

1. Enter the width of the digital image in pixels on this line.
2. Enter the height of the digital image in pixels on this line.
3. Enter the number of dots per inch (dpi) printed by your printer on this line.
4. A formula on this line calculates the horizontal size (width) of the image in inches by dividing the image's width in pixels by the printer's dpi.
5. A formula on this line calculates the vertical size (height) of the image in inches by dividing the image's height in pixels by the printer's dpi.

## ▲ Exercises

1. If your image is 1600 x 1200 and your printer's resolution is 600 dpi, how big will the print be?

2. If your image is 800 x 600 and your printer's resolution is 300 dpi, how big will the print be?

3. If your printer prints 300 dpi, how wide will an image have to be in pixels, to get a 6-inch wide print?

4. Using the widths and heights listed in the "Original" column and the specified printer dpi's, calculate the width and height of the prints you'd get.

Original 800 x 600, printed at 300 dpi is \_\_\_\_ x \_\_\_\_

Original 800 x 600, printed at 600 dpi is \_\_\_\_ x \_\_\_\_

Original 1600 x 1200, printed at 300 dpi is \_\_\_\_ x \_\_\_\_

Original 1600 x 1200, printed at 600 dpi is \_\_\_\_ x \_\_\_\_

Original 1800 x 1600, printed at 300 dpi is \_\_\_\_ x \_\_\_\_

Original 1800 x 1600, printed at 600 dpi is \_\_\_\_ x \_\_\_\_

### **Understanding pixels per inch (may be a new section)**

Normally you don't have to change the number of pixel's in an image to change the size of a printout. That task is handled by the software program you use to print the image. For example, if you place an image in a program such as QuarkXpress or PageMaker, its printed at the size you specify in those programs.

One thing to keep in mind is that if you enlarge a print too much, it won't be as sharp as you may desire. That's because a certain minimal number of dots per inch, usually about 300, are needed to get a good print. Pixels begin to show when the print is enlarged to a point where the pixels get get so big that the pixels per inch (ppi) fall too low. If your printer can print a sharp image only at 300 or more pixels per inch, you need to determine if the size of the image you plan on printing will fall below this level. Let's say you have a scanned image and want to print it at a certain size. When you enlarge or reduce an image like this, the ppi change. To find out what the pixels (or dots) per inch becomes, you convert from the image's original size in pixels to its pixels per inch. For example, if you print an image that's 1600 pixels wide so the print is 10" wide, there are only 160 dots per inch (unless its resampled) ( $1600 \text{ pixels} \div 10 \text{ inches} = 160 \text{ pixels per inch}$ ). When you know the width of the image in pixels, you can divide that number by the printer's dpi to determine the largest possible print size in inches.

### **Exploring Print DPI**

This figure and Part 3b on the Excel worksheet "[Image Size Calculator](#)" calculates the dpi of a print when you use a program that automatically resizes a file for printing.

3b. Printing Images-DPI		
1	Width of digital image	1,600 pixels
2	Height of digital image	1,200 pixels
3	Desired width of print	6 inches
4	Height of print	4.5 inches
5	DPI	267 dpi

1. Enter the width of the digital image in pixels on this line.
2. Enter the height of the digital image in pixels on this line.
3. Enter with desired width of your printout on this line.
4. A formula on this line calculates the height of the print so it has the same aspect ratio as the digital image.
5. A formula on this line calculates the dpi used to make the print by dividing it's width in pixels by its width in inches.